

BIOSYNTHESIS OF COPPER NANOPARTICLES BY USING ROOT EXTRACT OF OCIMUM SANCTUM (TULSI PLANT)

N.H.Bansod^{1*}, G.N.Chaudhari¹, S.S.wagh²

¹Department of Chemistry, Shri Shivaji Science College, Amravati (MS) 444603, India.

²Department of Chemistry Aadarsha College, Hingoli (MS) - 431003, India.

Abstract

Nanotechnology is the scientific field that has recently expanded due to its applications in pharmaceutical field, various industry and agriculture. The present study outlines the development of a method to synthesize copper nanoparticles (CuNPs) by mixing copper nitrate solution with aqueous root extract of Ocimum sanctum without using any surfactant or external energy. The green synthesized Copper nanoparticles (CuNPs) were characterized by UV-Vis spectroscopy, FTIR, and SEM. The XRD shows that crystalline nature of Copper nanoparticle with particle size range between 17-22 nm, which was also confirmed by FTIR Spectra. The surface morphology shows Copper a nanoparticle has globular morphology.

Keywords: biosynthesis, nanoparticles, X-ray techniques, FTIR, SEM.

1. Introduction

In recent years, the synthesis and use of metal nanoparticles have gained consideration due to their unique electrical, antibacterial, catalytic and magnetic properties [1-3] which are different from bulk materials. The synthesis of inorganic has been carried out by many chemical and physical methods. These are suffering from drawbacks like expensive reagent, hazardous reaction condition, longer time, tedious process to isolate nanoparticles. Hence, there is scope to develop new methods for the synthesis of nanoparticles which should be required inexpensive reagent, less drastic reaction condition and eco-friendly. The biosynthesis of nanoparticles has been proposed as a cost-effective and environmentally friendly alternative to chemical and physical methods. Plant-mediated synthesis of nanoparticles is a green chemistry approach that connects nanotechnology with plants. Novel methods of ideally synthesizing NPs are thus thought that are formed at ambient temperatures, neutral pH, low costs and environmentally friendly fashion. Keeping these goals in view nanomaterials have been synthesized using various routes. Among the biological alternatives, plants and plant extracts seem to be the best option. Plants are nature's "chemical factories". They are cost efficient and require low maintenance. The advantages and disadvantages of nanotechnology can be easily enumerated.

Currently, there is a growing need to develop environmentally benign metal nanoparticle synthesis processes that do not use toxic chemicals in the synthesis protocols to avoid adverse effects in medical applications. Copper nanoparticles have received attention due to its antimicrobial properties [4]. Physical and chemical methods of nanoparticle synthesis [5-13] are not environmentally friendly. Natural environment is a rich source of crude untreated extracts of plants, roots, marine organisms and microorganisms and it is crucial to investigate their various properties. Hence, there is scope to develop new microwave assisted methods for the synthesis of nanoparticles which should be required inexpensive reagent, less drastic reaction condition and eco-friendly.

2. Materials and methods

2.1. Reagents

15g of dry powder of *Ocimum sanctum* roots (Tulsi), 100 ml de-ionized water. $\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$ was procured from high media chemicals, Mumbai.

2.2. Preparation of root extracts

Fresh and healthy roots of medicinal plants, *Ocimum sanctum* were thoroughly rinsed with tap water followed by distilled water to remove dust particles and were further dried. About 15g of roots were ground into fine powder and transferred into two beakers, each containing 100 ml distilled water. The broth was boiled for 15 min. The extracts were cooled to room temperature and filtered through whatman filter paper No. 1 to remove particulate matter. The filtrate obtained was then stored in refrigerator at 4° .

2.3. Green synthesis of Copper nanoparticles (CuNPs)

In typical microwave synthesis, aqueous solution (0.01M) of copper nitrate [$\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$] was prepared in 250 ml Erlenmeyer flasks and extract was added for reduction into Ag^+ ions. The composite mixture was then kept on hotplate of micro oven (RAGA'S Microwave system, 700 W) for a period of 20 min at 60°C for complete bioreduction of copper sulphate. The change in colour from yellow to dark brown indicated the double distilled water (negative control), soaked in solution containing CuNPs. Filter and dry it. The dry powder of CuNPs was calcinated at 300°C in muffle furnace.



Fig. 1 Colour change from brown to blue

3. Results and discussion

3.1. X- Ray Diffraction

The crystalline nature of copper nanoparticles was further confirmed from X-ray diffraction (XRD) analysis. Fig. 2 shows the XRD pattern of the dried nanoparticles obtained from copper colloid. The pattern shows a high crystallinity of Cu sample level with diffraction angles of 35.4° , 38.5° , 48.7° , 53.3° and 58.1° , which correspond to the characteristic face centered cubic (FCC) of copper (JCPDS, file no.04-0836) lines indexed at (002) (111) (112) (202) (112) respectively.

The (111) peaks shows variation in the intensity at 38.59° Bragg's angle. The grain size of CuNPs was determined using the Debye Scherrer equation.

$$D = K \lambda / \beta \cos\theta$$

Where K is constant equal to 0.94, D and λ are the particle size in nanometer and wavelength of the radiation (1.54056 \AA for Cu $K\alpha$ radiation) respectively. β and θ are the peak width at half-maximum intensity (FWHM) and peak position. The average crystallite size of CuNPs was found to be 17-22 nm. With increasing heating time, an increase in the size of the particles was observed.

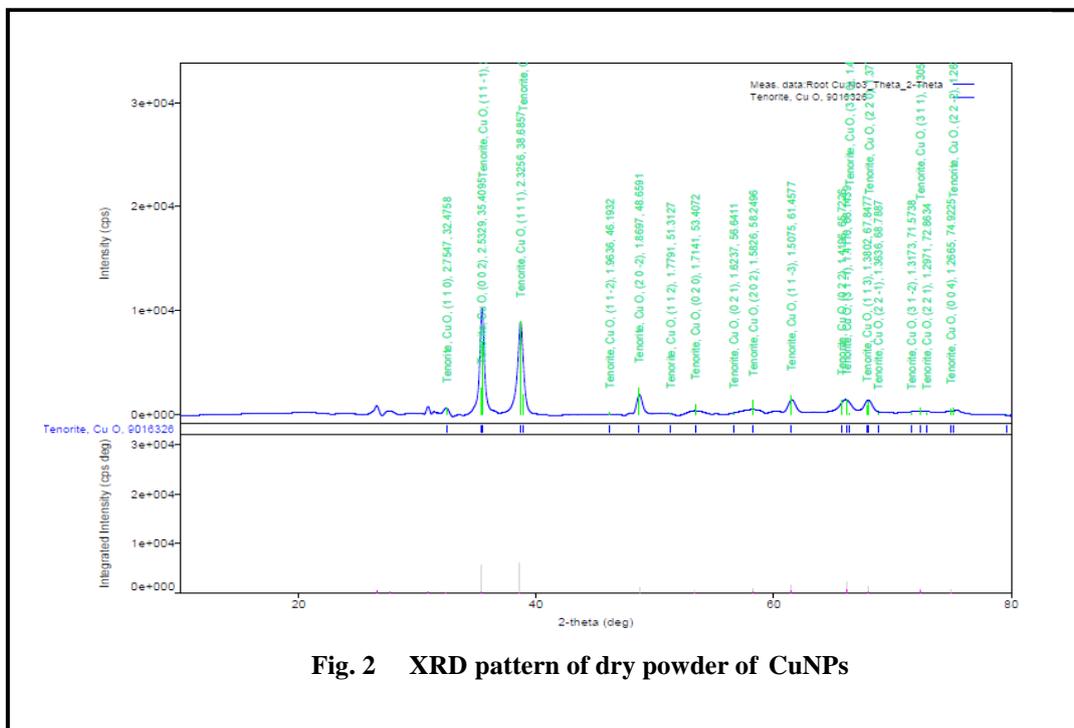


Fig. 2 XRD pattern of dry powder of CuNPs

3.2. FTIR Spectroscopy

The FTIR studies have been carried out to identify the presence of possible vibrational modes of different molecules responsible for the reduction and capping of the CuNPs.

The FTIR spectrum of CuNPs is shown in Fig. 3. The IR spectrum of Cu nanoparticles shows band at 3352 cm^{-1} , 1643 cm^{-1} , 1516 cm^{-1} , 1381 cm^{-1} , 1198 cm^{-1} corresponds to O-H Stretching H-bonded alcohols and phenols, carbonyl stretching, N-H bend primary amines, corresponds to C-N stretching of the aromatic amino group and C-O stretching alcohols, ethers respectively. FTIR spectrum of Cu nanoparticles suggested that Cu nanoparticles were surrounded by different organic molecules such as terpenoids, alcohols, ketones, aldehydes and carboxylic acid.

The FTIR spectra also contain various vibrational bands centered at 486.09 , 528.5 cm^{-1} due to the presence of Cu-O bond. The peaks 1516.6 cm^{-1} , 1689.2 cm^{-1} are the characteristic asymmetric stretching vibration of N-O compounds. [19-23] Therefore it is assumed that these biomolecules are work as capping agent and efficient stabilization.

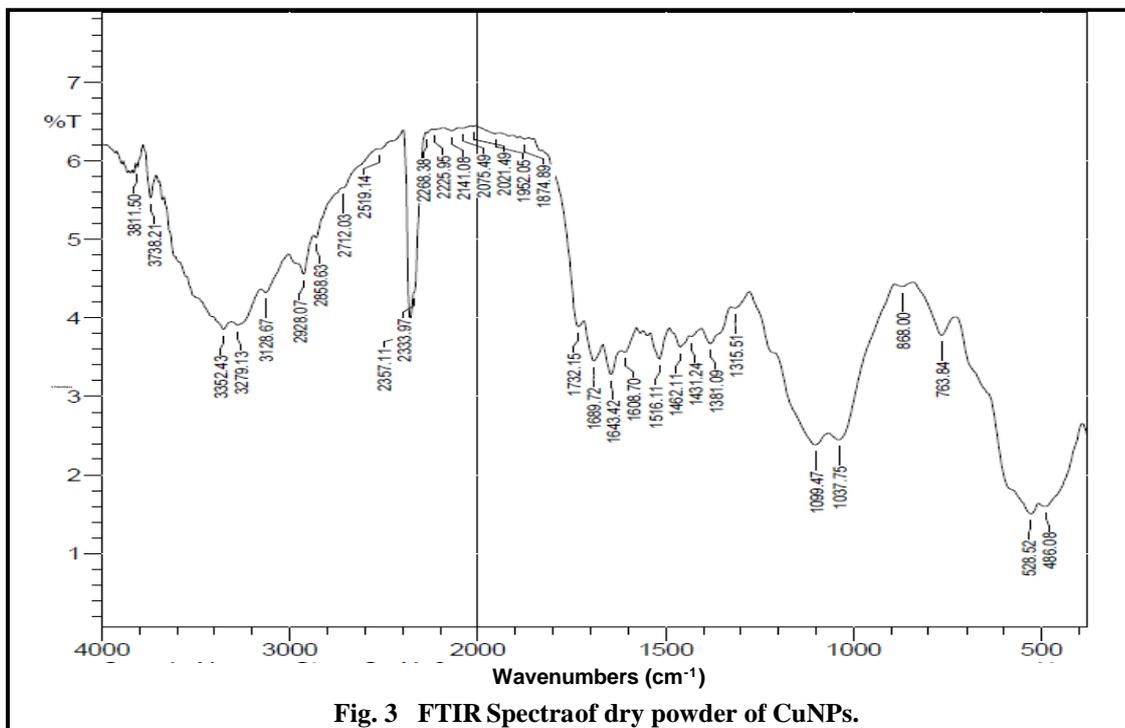


Fig. 3 FTIR Spectra of dry powder of CuNPs.

3.3. UV- Visible Absorbance studies

To observe the optical property of biosynthesized Copper nanoparticles, samples were periodically analyzed with UV Vis spectroscopic studies (Shimadzu UV-1800) at room temperature operated at a resolution of 1 nm between 200 and 600 nm ranges. Cuvette of path length 10 mm was used.

Figure 4. shows UV-Vis absorption spectrum of copper nanoparticles. it is observed that the silver SPR occurs at 408.0 nm. There is no change in peak position, suggesting that nucleation of copper nanoparticles starts with initiation of reaction time only, and the size remains unchanged throughout the course of reaction.[17] Broadening of the absorption peak at 408.0 nm with increase in time indicated the polydispersity of the nanoparticles.[18]

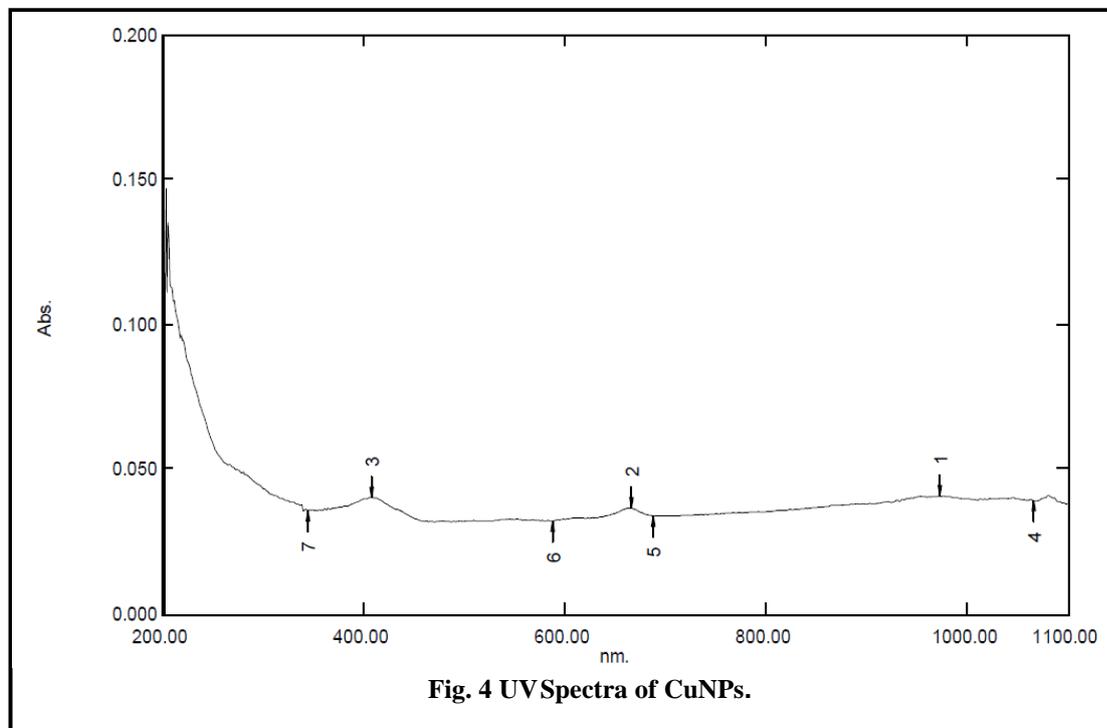


Fig. 4 UV Spectra of CuNPs.

3.4. Scanning Electron Microscopy (SEM)

The clear magnified SEM images at the accelerating voltage 10 kV with working distance of the sample 13.5 nm showed that nanoparticles were in nano flake with uniform shape distribution. Fig. 5 showed SEM images of copper nanoparticles were nanoflakes shape. Similar results were observed by saran yaadevi et al (2014) [15] and Hariprasad et al (2016)[16]

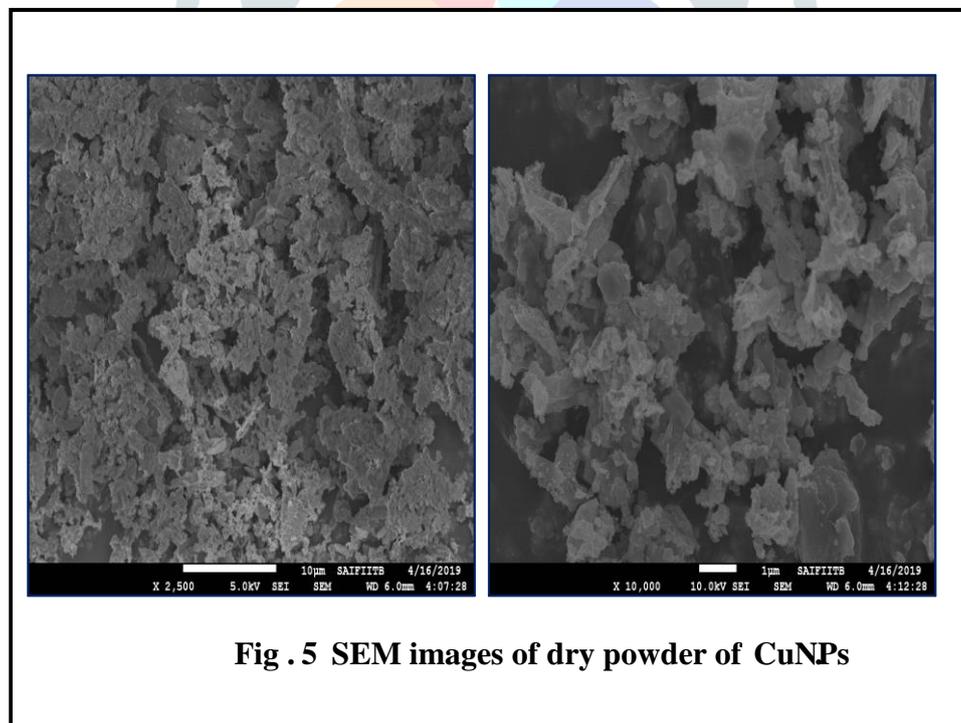


Fig . 5 SEM images of dry powder of CuNPs

4. Conclusion

In conclusion, we have developed a very simple, efficient, practical method for the synthesis of copper nanoparticles (CuNPs) using aqueous root extract of *Ocimum sanctum* (Tulsi) as both reducing and capping agent, under the influence of microwave irradiation. The copper nanoparticles were synthesized in

the range between 17-22 nm in size with nearly spherical in shape. The UV- Visible spectrum of Cu NPs recorded maximum absorption sharp band edge at 408 nm. The SEM analysis shows that Copper nanoparticles (CuNPs) were circular or spherical in shape and Agglomerated with time.

References

1. Gates, B.C., 1995. Chem. Rev. 95: 511-522.
2. Hwang, C.B., Fu, Y.S., Lu, Y.L., Jang, S.W., Chou, P.T., Wang, C.C.R., Yu, S.J., 2000. J. Catal. 195 (2): 336-341.
3. Narayanan, R., El-Sayed, M.A., 2003. J. Am. Chem. Soc. 125: 8340-8347
4. Parikh P., Zala D., Open Access lib (3) 2014: 1-15
5. C. Petit, P. Lixon, M.P. Pileni, J. Phys. Chem. 97 (1993) 12974.
6. S.A. Vorobyova, A.I. Lesnikovich, N.S. Sobal, Colloids Surf. A 152 (1999) 375.
7. G. Sandmann, H. Dietz, W. Plieth, J. Electroanal. Chem. 491 (2000) 78.
8. S. Keki, J. Torok, G. Deak, et al., J. Colloid Interface Sci. 229 (2000) 550.
9. C.H. Bae, S.H. Nam, S.M. Park, Appl. Surf. Sci. 197 (2002) 628.
10. Y. Tan, Y. Wang, L. Jiang, et al., J. Colloid Interface Sci. 249 (2002) 336.
11. C. Liu, L.H. Lin, Electrochem. Commun. 6 (2004) 1163.
12. M.J. Witcomb, M.S. Scurrilla, Mater. Chem. Phys. 90 (2005) 221.
13. A.B. Smetana, K.J. Klabunde, C.M. Sorensen, J. Colloid Interface Sci. 284 (2005) 521.
14. D.G. Yu, Colloids Surf. B 59 (2007) 171.
15. Hariprasad Int J. Chem. Tech . Res., 9(2):98
16. Saranyaadevi Int J. Chem. Tech . Res., 8(10): 4533
17. D. Philip, Spectrochim. Acta A 73 (2009) 374.
18. A.G.R. Nair, R. Gunasegaran, Indian J. Chem. 21 (1982) 979.
19. K.B. Narayanan, N. Sakthivel, Mater. Lett. 62 (2008) 4588
20. D. Philip, Physica E 42 (2010) 1417.
21. H. Schulz, M. Baranska, Vib. Spectrosc. 43 (2007) 13.
22. J. Huang, Q. Li, D. Sun, Y. Lu, Y. Su, X. Yang, H. Wang, W. Shao, N. He,
23. J.Hong, C. Chen, Nanotechnology 18 (2007) 105104.